

ZOOLOGY.—*North American monogenetic trematodes. II. The families Monocotylidae, Microbothriidae, Acanthocotylidae and Udonellidae (Capsaloidea).*¹ EMMETT W. PRICE. U. S. Bureau of Animal Industry.

Family MICROBOTHRIIDAE Price, 1936

Synonyms.—Dermophagidae MacCallum, 1926; Labontidae MacCallum, 1927.

Diagnosis.—Anterior haptors present or absent; when present, in form of sucker-like structures. Posterior haptor small, without septa or hooks. Eyes usually absent. Intestinal tract consisting of 2 branches, with or without lateral diverticula. Genital apertures close together or opening into a common genital sinus. Cirrus cuticularized, or muscular with a heavily cuticularized ejaculatory duct. Vagina single or double.

Type genus.—*Microbothrium* Olsson, 1869.

The family names Dermophagidae MacCallum (1926) and Labontidae MacCallum (1927) are unavailable, since the genus *Dermophagus* MacCallum was preoccupied, and the genus *Labontes* MacCallum, which was proposed to replace *Dermophagus*, is shown later on in this paper to be a synonym of *Microbothrium* Olsson.

KEY TO SUBFAMILIES OF MICROBOTHRIIDAE

- One or two testes MICROBOTHRIINAE Price
- Numerous testes PSEUDOCOTYLINAE Monticelli

Subfamily MICROBOTHRIINAE, new name

Synonyms.—Anoplodiscinae Tagliani, 1912; Dermophaginae MacCallum, 1926; Labontinae MacCallum, 1927; Paracotylinae Southwell and Kirshner, 1937.

Diagnosis.—Anterior haptor in form of an oral sucker or of adoral pseudosuckers. Eyes present or absent. One or two testes. Vagina usually single (double in *Leptobothrium*).

Type genus.—*Microbothrium* Olsson, 1869.

KEY TO GENERA OF MICROBOTHRIINAE

- 1. Two testes *Dermophthirius* MacCallum
- One testis 2
- 2. Eyes present *Anoplodiscus* Sonsino
- Eyes absent 3
- 3. Intestinal branches without lateral dendritic diverticula
- *Leptocotyle* Monticelli
- Intestinal branches with lateral diverticula 4
- 4. Vagina single *Microbothrium* Olsson
- Vagina double *Leptobothrium* Gallien

Genus MICROBOTHRIUM Olsson, 1869

Synonyms.—*Dermophagus* MacCallum, 1926, not Dejean, 1833; *Labontes* MacCallum, 1927; *Philura* MacCallum, 1926.

¹ Continued from Vol. 28, No. 3. THIS JOURNAL. Received February 12, 1938.

Diagnosis.—Anterior haptors in form of 2 bothria-like structures opening into oral cavity; posterior haptor an elliptical, heavily cuticularized groove. Oral aperture subterminal, groove-like; intestinal branches with lateral, dendritic diverticula. Genital aperture median. Cirrus long, muscular, with heavily cuticularized ejaculatory duct. Testis single, equatorial. Vagina single, not opening into genital atrium.

Type species.—*Microbothrium apiculatum* Olsson, 1869.

This genus at present contains only the type species. Olsson (1869) questionably assigned to this genus a form from the dorsum of "*Rajae Batidis*," which he named *Microbothrium* (?) *fragile*. This form is now generally believed to be a parasitic triclad turbellarian, possibly identical with *Micropharynx parasitica* Jägerskiöld.

Microbothrium apiculatum Olsson, 1869

Figs. 1-2

Synonyms.—*Pseudocotyle apiculatum* (Olsson, 1869) Braun, 1890; *Philura orata* MacCallum, 1926; *Dermophagus squali* MacCallum, 1926.

Description.—Body elliptical, 1.7 to 3.2 mm long by 700μ to 1.6 mm wide, convex dorsally, flattened or slightly concave ventrally. Cephalic glands present. Anterior haptors in form of 2 sucker-like organs opening into mouth cavity; posterior haptor an elliptical opening, 150 to 225μ long, at posterior end of body, unarmed, its cavity lined with thick cuticle. Oral aperture slit-like, subterminal; prepharynx relatively long; pharynx ovoid to piriform, 190 to 300μ long by 200 to 266μ wide; esophagus very short; intestinal tract consisting of 2 relatively slender branches with a number of lateral, more or less dendritic diverticula. Nervous system not observed. Genital aperture median, about one-third of body length from anterior end. Cirrus long, muscular, lying in a rather spacious genital sinus; the ejaculatory duct, which passes through the center of the cirrus, strongly cuticularized and expanded proximally to form a more or less globular ejaculatory bulb. Vas deferens relatively large and expanded distally; seminal vesicle globular, about 80 to 170μ in diameter, at level of ovary. Testis circular in outline, with smooth or indented margins, 340 to 510μ in diameter, in equatorial zone. Ovary globular, 85 to 170μ in diameter, immediately pretesticular, to right of median line. Vitellaria extending from level of pharynx to within about 500μ from posterior end of body, meeting in median line posterior to testis. Vagina strongly muscular, convoluted, its proximal end expanded and forming a seminal receptacle, 40 to 115μ in diameter, between ovary and seminal vesicle; vaginal opening at level of genital aperture near left intestinal branch. Ootype piriform, about 190μ wide, surrounded by unicellular glands. Egg oval, about 130μ long by 80μ wide, with relatively short polar process.

Hosts.—*Squalus acanthias* Linn., and *Carcharias commersonii* (Blainville).

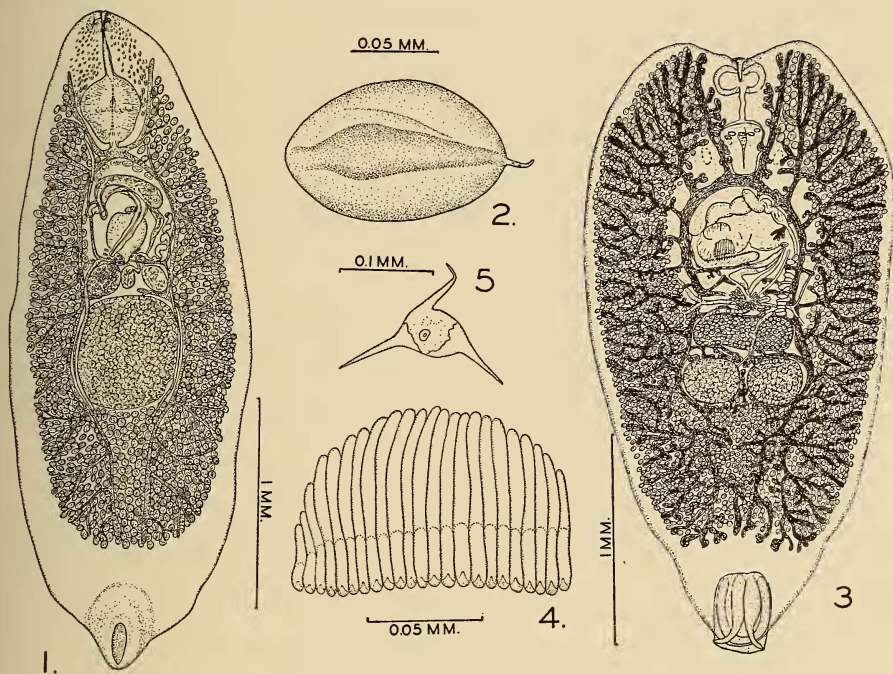
Location.—Skin.

Distribution.—United States (Woods Hole, Mass.) and Canada.

Specimens.—U.S.N.M. Helm. Coll. Nos. 35684 (cotypes of *Dermophagus squali*), 35685 (cotypes of *Philura orata*) and 35686.

Microbothrium apiculatum was first described by Olsson (1869) from specimens collected from the dorsum of "*Acanthiae vulgaris*" taken in the Skagerrak. The description was not very complete as to details of the genital systems; these details were supplied later by Saint-Remy (1891). The first

report of this species in North America is that by Stafford (1904) who listed *Pseudocotyle apiculatum* (= *Microbothrium apiculatum*) from *Squalus acanthias*, the specimens having been collected at the Canadian Marine Biological Station. MacCallum (1926) described as *Philura orata* n. g., n. sp., an ectoparasitic fluke from the skin of "*Carcharhinus commersonii*" collected at Woods Hole, Mass., and later in the same year (1926) he described as *Dermophagus squali*, n. g., n. sp., a somewhat similar fluke from *Squalus acanthias* also collected at Woods Hole, Mass. A study of these forms reveals



Figs. 1-2.—*Microbothrium apiculatum*. 1, complete worm, ventral view; 2, egg. Figs. 3-5.—*Dermophthirius carcharhini*. 3, complete worm, ventral view; 4, cirrus spines; 5, egg.

that both *Philura orata* and *Dermophagus squali* are identical with *Microbothrium apiculatum* Olsson. The specimens are not so large as the maximum size given by Olsson, Stafford or MacCallum, but aside from this they check in every essential with the description as given by Olsson and by Saint-Remy.

Genus LEPTOBOTHRIMUM Gallien, 1937

Synonym.—*Pseudobothrium* Gallien, 1937, nec Guiart, 1935.

Diagnosis.—Oral aperture subterminal, surrounded by a pseudosucker. Posterior haptor small, unarmed. Intestine with lateral non-dendritic diverticula, not uniting posteriorly. Eyes absent. Testis single; cirrus simple. Ovary small, pretesticular. Vagina present, bifurcating to form 2 branches both opening into genital atrium. Other characters similar to those of *Microbothrium*.

Type species.—*Leptobothrium pristiuri* (Gallien, 1937) Gallien, 1937.

The type and only species of this genus was described by Gallien (1937), from specimens collected from the skin of *Pristiurus melanostomus* taken in European waters.

Genus LEPTOCOTYLE Monticelli, 1905

Synonym.—*Paracotyle* Johnstone, 1911.

Diagnosis.—Anterior haptor in form of a weakly developed oral sucker. Intestinal branches without lateral dendritic diverticula. Other characters similar to those of *Microbothrium*.

Type species.—*Leptocotyle minor* (Monticelli, 1888) Gallien, 1937.

Leptocotyle was proposed by Monticelli (1905) as a subgenus of *Pseudocotyle* to contain *Pseudocotyle minor*, a species named by Monticelli (1888) but not described until 1890. Johnstone (1911) described a form which seems to be identical with *P. minor* Monticelli, naming the species *Paracotyle caniculae*. Tagliani (1912) raised the subgenus *Leptocotyle* to the rank of a genus but failed to include in it the species for which the subgenus was originally proposed; he did, however, recognize the identity of *Paracotyle* and *Leptocotyle*. Recently Jones (1933) redescribed Johnstone's *Paracotyle caniculae* and considered it congeneric with *Microbothrium apiculatum* Olsson; he apparently did not know of *Pseudocotyle minor* Monticelli, as no mention of it was made. In comparing the descriptions and figures of *P. minor* Monticelli with those of *Paracotyle caniculae* Johnstone, there appear to be no essential differences and it is the writer's opinion that the two forms are identical; this conclusion supports that of Gallien (1937).

Genus DERMOPHTHIRIUS MacCallum, 1926

Diagnosis.—Anterior haptors in form of 2 bothria opening into oral cavity; posterior haptor consisting of 2 clamp-like cuticular jaws resembling the valves of a clam shell, unarmed. Oral aperture slightly subterminal; intestinal branches similar to but more conspicuous than those of *Microbothrium*. Genital aperture sinistral. Cirrus muscular, armed with a group of 2 overlapping rows of stave-like spines in the thicker ventral wall and a single row of short simple spines in the thinner dorsal wall. Two testes, side by side, postequatorial. Vagina single.

Type species.—*Dermophthirius carcharhini* MacCallum, 1926.

Dermophthirius carcharhini MacCallum, 1926

Figs. 3-5

Description.—Body elongate, ovoid, 1.9 to 2.9 mm long by 850 μ to 1.5 mm wide at level of pharynx. Anterior haptor in form of bothria opening into oral cavity; posterior haptor clam shell-like, about 340 μ long, strongly cuticular, its inner surface roughened but without hooks. The exact shape and function of this haptor could not be ascertained in the specimens available owing to the large amount of detritus caught in its jaws. Oral aperture slightly subterminal; prepharynx moderately long and spacious; pharynx piriform, widest anteriorly, 190 to 245 μ long by 95 to 228 μ wide, projecting into a widened prepharynx; esophagus absent; intestinal branches with long lateral and shorter median dendritic diverticula. Nervous system not ascertainable; eyes absent. Excretory apertures dorsal, at level of pharynx. Genital aperture to left of median line and about midway between base of pharynx and anterior margin of ovary. Genital sinus spacious. Cirrus muscular and of peculiar shape; ventral wall greatly thickened and bearing

on its inner surface 2 rows of stave-like spines, the innermost row of about 25 spines 19 to 40μ long and outermost row of about 25 spines 25 to 70μ long; dorsal wall thinner and bearing a single row of about 28 straight spines having a maximum length of about 20μ . Vas deferens convoluted proximally, widening and forming a seminal vesicle slightly anterior to level of cirrus, then passing into a long, conspicuous, convoluted prostatic portion lying immediately anterior to cirrus; prostatic portion lined with high columnar epithelium. Testes round, 150 to 285μ in diameter, side by side, immediately postovarial. Ovary elongate transversely, 90 to 190μ long by 230 to 455μ wide, median, slightly postequatorial. Vitellaria consisting of relatively large follicles occupying greater part of body, except that occupied by genital organs, extending from anterior end of body to posterior limits of intestinal diverticula. Vagina slender, opening near genital aperture. Ootype median, surrounded at its base by unicellular glands; metaterm short and thin walled. Egg tripolar, about 76μ long (excluding polar prolongations).

Host.—*Carcharias commersonii* (Blainville).

Location.—Olfactory organs and skin of back.

Distribution.—United States (Woods Hole, Mass.).

Specimens.—U.S.N.M. Helm. Coll. Nos. 35687 (cotypes), 35688, and 36644.

This species has been described very accurately by MacCallum (1926) except for a few details. The common genital aperture is not median but somewhat sinistral; the vaginal aperture is also somewhat sinistral. The posterior haptor is not in the form of a shallow groove, as originally figured and described, but consists of a pair of jaw-like cuticularized structures which have somewhat the appearance of the valves of a clam shell. In most of the specimens the posterior haptor has been torn off and the description of the posterior sucker or haptor as given by MacCallum was obviously from one of these mutilated specimens. The exact detail of the haptor could not be made out because of the mass of detritus clamped between the jaws; it must possess enormous powers of attachment as it had been torn from all but 3 of about 20 specimens examined.

Genus ANOPLODISCUS Sonsino, 1890

Diagnosis.—Anterior haptors in form of a pair of pseudosuckers situated at anterior end of body. Posterior haptor cup-like, unarmed. Eyes present. Cirrus cuticularized, with accessory piece. Testis single, preequatorial. Ovary pretesticular. Vagina present.

Type species.—*Anoplodiscus richiardii* Sonsino, 1890.

The type species of *Anoplodiscus*, *A. richiardii*, was originally described by Sonsino (1890) from the gills of *Pagrus orphus* from the Mediterranean, and was subsequently redescribed by Monticelli (1905); neither description is adequate. The only other species so far included in this genus is *A. australis* which was described by Johnston (1930) from specimens collected from the fin of *Sparus australis* taken at Sydney Harbour, Australia.

The systematic position of the genus *Anoplodiscus* is not well established. Monticelli placed it in the Anisocotylinæ Monticelli, 1903—a subfamily

without a corresponding genus and consequently invalid—and later Tagliani (1912) erected for it the subfamily Anoplodiscinae, elevating Monticelli's invalid Anisocotylinae to the status of an invalid family Anisocotylidae. Johnston and Tiegs (1922) consider *Anoplodiscus* as possibly belonging to the Calceostomidae, subfamily Dionchinae, while Fuhrmann (1928) and Gallien (1937) place it in the Pseudocotylinae. The present writer has, without prejudice, included *Anoplodiscus* in the Microbothriinae, mainly because the general organization and the lack of haptor hooks suggest relationship with such genera as *Microbothrium*, *Leptocotyle* and *Leptobothrium*. On the other hand, the presence in *Anoplodiscus* of eyes and a cirrus with accessory piece suggests affinities with genera of the Gyrodactyloidea. It is possible that a restudy of the species of *Anoplodiscus* may show the haptor to be armed with minute hooks in which case it should be transferred to the family Calceostomatidae (Gyrodactyloidea).

Subfamily PSEUDOCOTYLINAE Monticelli, 1903

Diagnosis.—Anterior haptors absent; posterior haptor small, suckerlike, unarmed. Eyes absent. Genital apertures close together, median. Testes numerous. Vagina double, not opening into genital atrium.

Type genus.—*Pseudocotyle* Beneden and Hesse, 1865.

Genus PSEUDOCOTYLE Beneden and Hesse, 1865

Diagnosis.—With characters of subfamily.

Type species.—*Pseudocotyle squatinae* Beneden and Hesse, 1865.

The genus *Pseudocotyle* contains only the type species; it has not been reported from North America.

Family ACANTHOCOTYLIDAE Price, 1936

Synonym.—Anisocotylidae Tagliani, 1912, in part.

Diagnosis.—Anterior haptors in form of retractile suckers or of weakly developed suckers surrounded by openings of cephalic gland ducts. Posterior haptor small, bearing usually 1 pair of centrally placed hooks and 14 marginal hooklets; sometimes with large disc-like pseudo-haptor bearing rows of spines, or with radial septa. Genital apertures separate; male aperture median or sublateral; female aperture lateral and marginal. Vagina (?). Testis single or multiple.

Type genus.—*Acanthocotyle* Monticelli, 1888.

The family Acanthocotylidae is erected to include 3 genera, viz., *Acanthocotyle* Monticelli, *Lophocotyle* Braun and *Enoplocotyle* Tagliani. The first two of these genera are included in the subfamily Acanthocotylinae Monticelli and the third in the subfamily Enoplocotylinae Tagliani.

Recent writers, including Johnston and Tiegs (1922) and Fuhrmann (1928), are not in agreement as to the affinities of these genera. Johnston and Tiegs place the genera *Acanthocotyle* and *Lophocotyle* in the Acanthocotylinae which they append to the superfamily Gyrodactyloidea; they do not mention the genus *Enoplocotyle*. Fuhrmann apparently does not recognize either the subfamily Acanthocotylinae or Enoplocotylinae, placing *Acanthocotyle*, *Lophocotyle* and *Enoplocotyle* in the family Monocotylidae.

The present writer regards the affinities of *Acanthocotyle*, *Lophocotyle* and *Enoplocotyle* such as to warrant the erection for them of a family separate from the Monocotylidae. In these genera the male and female genital apertures are relatively far removed, while in the Monocotylidae the male and female apertures are close together. Furthermore, in both *Acanthocotyle* and *Enoplocotyle*, and possibly also in *Lophocotyle*, the cephalic gland ducts open around the margins of the anterior sucker-like haptors; this is not the case in the Monocotylidae.

KEY TO SUBFAMILIES OF ACANTHOCOTYLIDAE

- Posterior haptor very small, situated at margin of large disc-like pseudohaptor bearing radial rows of spines, or with muscular septa. ACANTHOCOTYLINAE Monticelli
- Posterior haptor relatively large, without pseudohaptor. ENOPLCOTYLINAE Tagliani

Subfamily ACANTHOCOTYLINAE Monticelli, 1903

Diagnosis.—Anterior haptors in form of 2 retractile suckers, or of corresponding concentrations of cephalic gland ducts. Posterior haptor very small, at margin of large disc-like pseudohaptor. Testes numerous.

Type genus.—*Acanthocotyle* Monticelli, 1888.

The posterior adhesive organs in members of the Acanthocotylinae differ from those occurring in other representatives of the Capsaloidea in consisting of a large sucker-like structure provided with a small armed disc situated at its posterior margin. The large sucker bears on its ventral surface either radial ridges (*Lophocotyle*) or radial rows of spines (*Acanthocotyle*); this structure has been termed a pseudohaptor (Price, 1937). The small disc is the true haptor and is undoubtedly homologous with the haptor of gyroductylids, dactylogyrids, monocotylids and capsalids, since it is armed with hooks which are distributed as in the above forms. The spines of the pseudohaptor have usually been referred to as hooks, but since they are not provided with muscular attachments they can not be regarded as hooks in the same sense as those of the true haptor. In the present paper, as well as in others by the writer, the term *hook* is reserved for those cuticularized or chitinized structures which are freely movable due to muscular action, and the term *spine* is used for similar structures not provided with muscles; we may have, therefore, spine-like hooks as well as hook-like spines.

KEY TO GENERA OF ACANTHOCOTYLINAE

- Pseudohaptor with radial rows of spines. *Acanthocotyle* Monticelli
- Pseudohaptor without radial rows of spines. *Lophocotyle* Braun

Genus ACANTHOCOTYLE Monticelli, 1888

Diagnosis.—Anterior haptors in form of 2 retractile suckers; cephalic glands present, opening around margins of suckers. Pseudohaptor large, bearing radiating rows of irregularly shaped spines. Intestinal branches without lateral diverticula.

Type species.—*Acanthocotyle lobianchi* Monticelli, 1888.

The genus *Acanthocotyle* contains at present 9 apparently valid species as follows: *A. branchialis* Willem (1906), *A. elegans* Monticelli (1890), *A. lobianchi* Monticelli (1888), *A. monticellii*² Scott (1902), *A. oligoterus* Monticelli (1899), *A. pacifica* Guberlet (1937), *A. pugetensis* Guberlet (1937), *A. verrilli* Goto (1899), and *A. williamsi*, n. sp.; all except the last four of these species occur on European rays and are not known to occur on North American hosts.

Acanthocotyle williamsi, n. sp.

Fig. 6-9

Description.—Body linguiform, flat, 3.7 to 4.4 mm long by 1.3 to 1.6 mm wide. Anterior sucker-like haptors 150 μ long by 110 μ wide, retracted into groove-like depressions. Cephalic glands present, opening around margins of haptors as in other species of the genus. Pseudohaptor disc-like, 1.2 to 1.3 mm in diameter, its ventral surface provided with 20 rows (21 rows in 1 specimen) of strong spines, the 2 most posterior rows with 3 to 6 spines each and the other rows with 6 to 10 each; outermost spines longest, truncate at tips. Posterior haptor 55 to 65 μ in diameter, situated at distal margin of pseudohaptor, armed with 16 hooks, 2 centrals and 14 marginals, each about 18 to 20 μ long. Oral aperture ventral, median, about 240 μ from anterior end of body. Pharynx globular, 320 to 400 μ in diameter. Esophagus very short; intestinal branches simple, without diverticula. Brain anterodorsal of oral aperture; no eyes; one pair of sensory papillae near anterior margin, immediately median to haptors. Excretory vesicles anterior to vitellaria, opening dorsally near lateral margins of body. Male genital aperture median or slightly submedian, immediately posterior to base of pharynx. Cirrus pouch relatively large, curved, containing an internal seminal vesicle and a relatively short cirrus; vas deferens enlarged and constricted to form 2 external seminal vesicles, the most posterior being rosette-shaped. Paired prostatic vesicles present, one on each side of cirrus pouch, extending from level of middle of anterior seminal vesicle to genital aperture; these lie entirely outside the cirrus pouch and are often voluminous. Testes 32 to 57 in number, in intercecal field posterior to ovary. Ovary globular, 270 to 320 μ in diameter, median, about one-third of body length from anterior end. Vitellaria extracecal, consisting of large elongate follicles, extending from level of ovary to near posterior end of body proper. Seminal receptacle present, postero-dorsal of ovary; vagina absent. Ootype elongate, in median field, uniting with uterus by means of a short slender duct; uterus cylindrical, relatively short, opening into relatively large club-shaped muscular metraterm. Female aperture dextral, dorsal, at level of anterior part of pharynx. Egg 275 μ long, exclusive of filament, by 68 μ wide.

Host.—"Skate."

Location.—Skin.

Distribution.—Aleutian Islands (Salt Island).

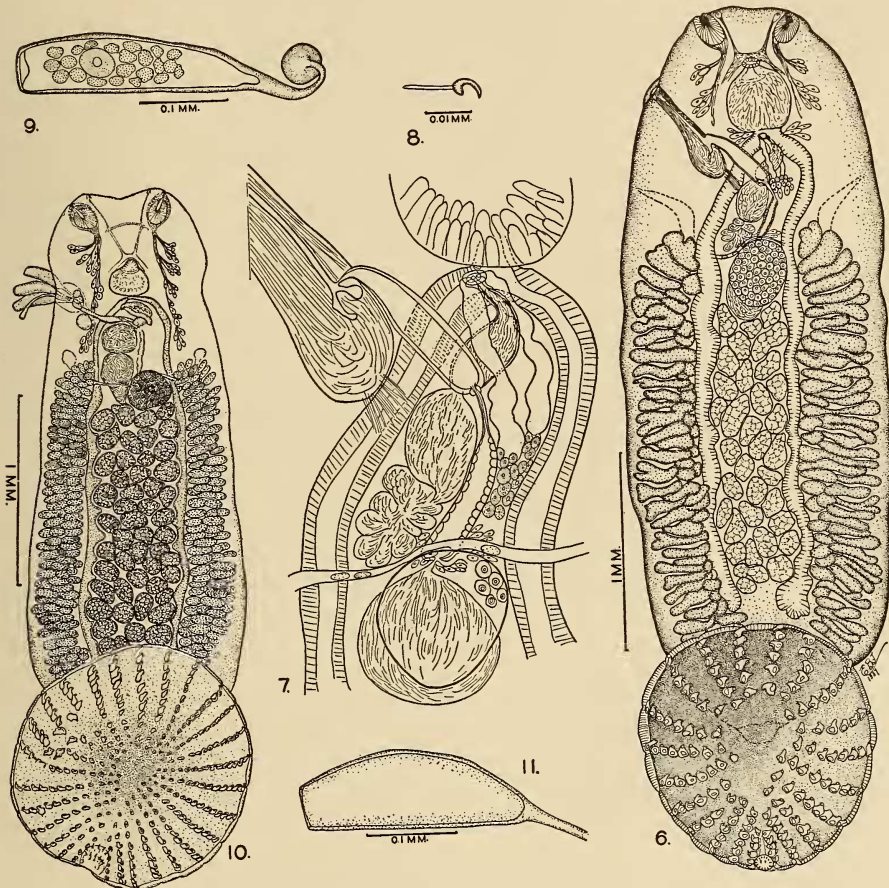
Specimens.—U.S.N.M. Helm. Coll. No. 9033 cotypes; collected July 7, 1936, by C. S. Williams, for whom the species is named.

This species appears to resemble more closely *A. branchialis* Willem than any of the other species of *Acanthocotyle*. The two species differ mainly in the number of pseudohaptoral spines, there being 7 to 8 spines in the most

² *Acanthocotyle concinna* Scott, 1902, appears to be a lapsus for *A. monticellii*; the name is mentioned only once and then in connection with a comparison of *A. monticellii* with other species of the genus.

posterior rows and 9 to 14 in the others in *A. branchialis*, and 3 to 6 in the most posterior rows and 6 to 10 in the others in *A. williamsi*.

A study of specimens of this and some other species of *Acanthocotyle* has convinced the writer that Monticelli (1899) was in error in interpreting parts of the male and female genital systems in species of this genus. According to Monticelli's descriptions and very elaborate figures of these systems



Figs. 6-9.—*Acanthocotyle williamsi*. 6, complete worm, ventral view; 7, male and female genital complex; 8, haptor hook; 9, egg. Figs. 10-11.—*Acanthocotyle verrilli*. 10, complete worm, ventral view; 11, egg.

in the species described by him, there is a large cirrus sac containing a cirrus, internal seminal vesicle and a prostatic vesicle. He also described and figured a vagina extending from the seminal receptacle and opening near the male aperture. According to the present writer's observations on serial sections and toto mounts of several specimens of *A. williamsi*, as well as observations on specimens of *A. verrilli* and two species kindly supplied by Kelsaw Bonham, University of Washington, Seattle, Wash., the cirrus pouch is very delicate

and encloses only a small cirrus and a large internal seminal vesicle; the prostatic vesicles are two in number, both lying free in the parenchyma, one on each side of the cirrus pouch, and opening opposite each other in a shallow genital atrium. There is no trace of either a vaginal aperture or a vagina in any of the species studied, and it appears that what was regarded as a vagina by Monticelli was one of the prostatic vesicles. The conclusion that a vagina is absent in species of *Acanthocotyle* is supported by Willem (1906) who stated that he was unable to demonstrate this structure in specimens of *A. branchialis*.

Acanthocotyle verrilli Goto, 1899

Figs. 10-11

Description.—Body linguiform, almost rectangular, flat, 3.5 to 3.89 mm long by 1.2 to 1.3 mm wide, slightly constricted at level of pharynx. Anterior haptors in form of a pair of suckers, each about 114 μ wide, retracted into groove-like depressions. Cephalic glands present, their ducts opening at margins of anterior haptors. Pseudohaptor disc-like, 1.28 to 1.36 mm in diameter, slightly concave, with 30 radial rows of irregularly shaped spines, 4 to 15 in each row, outermost spines longer than others and with truncate tips; posterior haptor about 130 μ in diameter, at posterior margin of pseudohaptor, armed with 16 hooks, 2 centrals and 14 marginals, each about 30 μ long. Oral opening ventral, about 340 to 425 μ from anterior end of body. Pharynx piriform, 190 to 285 μ long by 247 to 293 μ wide; esophagus extremely short; intestinal branches with slight median diverticula, terminating near posterior end of body proper. Nervous system not completely ascertainable; brain immediately anterior to oral aperture; eyes absent; 1 pair of sensory papillae situated at anterior margin of body, 1 papilla median to each haptor. Excretory vesicles immediately anterior to vitellaria, opening dorsally near lateral margins of body. Male genital aperture submedian, about 570 μ from anterior end of body; cirrus relatively short; vas deferens dilated and constricted to form 2 seminal vesicles. Paired prostate vesicles present, one opening on each side of male genital aperture. Testes about 57 in number, in interintestinal field posterior to ovary. Ovary globular, 210 to 228 μ in diameter, submedian, pretesticular. Vitellaria extracecal, consisting of large follicles and extending from ovarian zone to posterior end of body proper. Vagina absent. Ootype relatively wide, extending anteriorly in median line, joined by slender duct to the relatively long uterus; metraterm relatively wide. Egg 259 μ long, exclusive of filament, by 80 μ wide.

Hosts.—*Raja erinacea* Mitchell, *R. radiata* Donovan, and "blue fish."

Location.—Skin.

Distribution.—United States (North Atlantic). Reported from Cape Cod, Mass., by Goto (1899); from Canada by Stafford (1904); and from off the coast of Maine by Manter (1926).

Specimens.—U.S.N.M. Helm. Coll. No. 7175.

The description given here is based on 2 specimens from a "blue fish," collector unknown, which were found in the U. S. National Museum.

This species appears to be somewhat variable, as considerable difference was noted between the specimens studied by the writer and those described by Goto (1899) and by Manter (1926); these differences, however, were more or less minor, being in the number of testes and in the number of rows of spines on the pseudohaptor. Goto reported the number of testes as 37 and

Manter as 52, while in the writer's specimens there were at least 57. The number of rows of spines on the pseudohaptor was given as 34 by Goto and 32 by Manter; in the writer's specimens there were 30 rows. In spite of these differences there seems to be no reason for regarding the specimens from the 3 collections as representing different species.

Acanthocotyle pacifica Guberlet, 1937

This species was reported by Guberlet (1937) as occurring on the skin and only rarely on the gills of *Raja binoculata* Girard, *R. stellulata* Jordan and Gilbert and *R. rhina* Jordan and Gilbert from the Pacific Coast. The only character given for this species was that the pseudohaptor bears 32 or more rows of spines.

Acanthocotyle pugetensis Guberlet, 1937

This species was reported as occurring principally on the gills of the same hosts as *A. pacifica*. The pseudohaptor bears 20 rows of spines.

Genus LOPHOCOTYLE Braun, 1896

Diagnosis.—Anterior haptors in form of 2 groups of cephalic gland duct openings. Pseudohaptor similar to that of *Acanthocotyle* but with muscular radii instead of rows of spines. Intestinal branches with lateral diverticula. Male and female genital apertures apparently not so widely separated as in *Acanthocotyle*; testes numerous.

Type species.—*Lophocotyle cyclophora* Braun (1896).

The type and only species of this genus was based on 2 specimens, collected at Puerto Toro by the Hamburg Magellan-Expedition "wahrscheinlich von der Haut eines Fisches der Gattung *Notothenia*." The specimens apparently were not in good condition as certain features of the worm were not well described. The general appearance, however, indicates a very close relationship with members of the genus *Acanthocotyle*.

Subfamily ENOPLOCOTYLINAE Tagliani, 1912

Diagnosis.—Anterior haptors in form of 2 very weakly developed suckers, with ducts of cephalic glands opening around them. Posterior haptor relatively large, with 1 pair of centrally placed hooks and 14 marginal hooklets, each of the latter located in center of an oval sucker-like depression. Testis single, immediately postovarial.

Type genus.—*Enoplocotyle* Tagliani, 1912.

Genus ENOPLOCOTYLE Tagliani, 1912

Diagnosis.—Characters of subfamily.

Type species.—*Enoplocotyle minima* Tagliani, 1912.

This genus contains only the type species; it is not known to occur in North American hosts.

Family UDONELLIDAE Taschenberg, 1879

Diagnosis.—Body elongate, cylindrical or subcylindrical; cuticula with distinct or indistinct annulations. Anterior haptors present or absent, when present, in form of 2 small suckers or sucker-like structures; cephalic glands present. Posterior haptor sucker-like, without radii, unarmed. Pharynx

well developed, protrusible. Intestine simple, sac-like, unbranched, sometimes fenestrate in testicular and ovarian zones. Genital aperture median or submarginal; cirrus absent; testis single. Ovary pretesticular, median. Egg oval or elongate piriform, with long filament at one pole.

Type genus.—*Udonella* Johnston, 1835.

Genus UDONELLA Johnston, 1835

Synonyms.—*Lintonia* Monticelli, 1904; *Calinella* Monticelli, 1910.

Diagnosis.—Anterior haptors in form of 2 small suckers or sucker-like structures; posterior haptor terminal, sucker-like, unarmed. Pharynx without hooks or spines; intestine simple, sac-like, sometimes fenestrate in ovarian and testicular zone.

Type species.—*Udonella caligorum* Johnston, 1835.

The genera *Lintonia* Monticelli (1904) and *Calinella* Monticelli (1910) are regarded as synonyms of *Udonella* Johnston, as the characters given for these genera are of no more than specific value. The type of *Lintonia*, *L. papillosa* (Linton), is shown further on in this paper to be the same as *Udonella socialis* Linton, and both are apparently identical with *U. caligorum* Johnston. *Calinella craneola* Monticelli shows a fenestration of the simple sac-like intestinal ceum but otherwise appears to be very similar to *U. caligorum*; this single character is not regarded as generic.

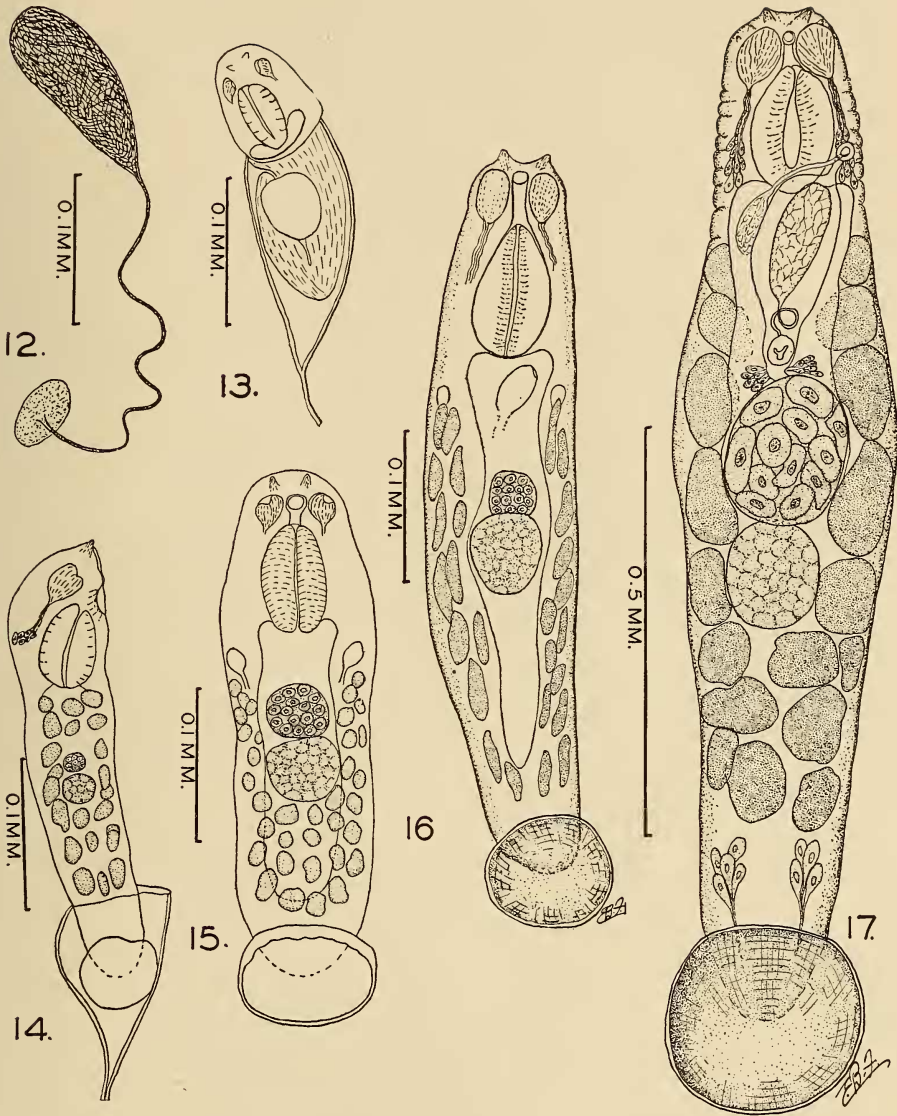
The genus *Udonella* contains at the present time the following species: *U. caligorum* Johnston, *U. craneola* (Monticelli), *U. lupi* Beneden and Hesse, *U. merlucii* Beneden and Hesse, *U. pollachii* Beneden and Hesse, *U. sciaenae* Beneden and Hesse, and *U. triglæ* Beneden and Hesse. Of these species only the first two, *U. caligorum* and *U. craneola*, appear to be distinguishable; the remaining species are imperfectly described and probably not all congeneric.

Udonella caligorum Johnston, 1835

Figs. 12–17

Synonyms.—*Nitzschia papillosa* Linton, 1898; *Lintonia papillosa* (Linton, 1898) Monticelli, 1904; *Udonella socialis* Linton, 1910; *Calinella myliobati* Guberlet, 1936.

Description.—Body elongate, 1.1 to 1.36 mm long by 255 μ wide at ovary, subcylindrical; cuticula of anterior end of body in mature specimens showing pseudoannulations. Anterior haptors sucker-like, retractile, about 42 to 57 μ wide; cephalic glands present, their ducts leading apparently to anterior haptors. Posterior haptor sucker-like, 187 to 210 μ in diameter, without septa or hooks. Caudal glands present, arranged in 2 submarginal groups near posterior end of body proper. Oral aperture subterminal, median. Pharynx oval, 150 to 152 μ long by 85 to 95 μ wide, apparently partially protrusible. Intestine simple, sac-like, unbranched, extending to near posterior end of body proper. Nervous system not observed; eyes absent; one pair of conspicuous sensory papillae present at anterior end of body. Excretory vesicles submarginal, at or slightly posterior to level of base of pharynx, conspicuous in small specimens. Genital aperture sinistral, submarginal, slightly anterior to level of posterior end of pharynx. Cirrus apparently absent; ejaculatory duct slender and leading from an oval seminal vesicle lying to right of anterior end of ootype. Testis single, median, 76 to 95 μ in diameter, equatorial. Ovary globular, 133 μ in diameter, median, pretesticular. Vitel-



Figs. 12-17.—*Udonella caligorum*. 12, egg; 13 and 14, egg hatching; 15 and 16, young forms showing different degrees of maturity; 17, adult worm.

larva consisting of few relatively large follicles, extending from slightly posterior to pharynx to a short distance anterior to posterior end of body. Vagina absent. Ootype large, vesicular, its base surrounded by unicellular glands; metraterm very short. Egg from balsam mounts elongate piriform, 133μ long by 42μ wide, with long slender filament expanded at tip to form an adhesive disc; the eggs were all considerably contracted and wrinkled and the measurements given are no doubt much less than would be those of unpreserved eggs.

Life history.—Immature forms in all stages of growth from escape of the larva from the egg to the fully mature adult were observed on the slide mount of *Udonella socialis*. These various growth stages showed very little of special significance. At the time of escape from the egg the worm appears to be virtually mature except for size; the smallest individual observed was 210μ long by 57μ wide. The most noticeable change during growth appears to be in the relative sizes of the ovary and testis; in immature stages the ovary is always distinctly smaller than the testis, while in fully grown adults the reverse is true. The life history of this species, so far as represented in the available material, is essentially the same as that given by Beneden (1858).

Hosts.—"Argulus sp." in mouth of *Neomaenis griseus*; *Caligus* sp., on *Gadus callarias* Linnaeus; and *Trebius latifurcatus*, parasite on *Myliobatis californicus* Gill.

Location.—Body and appendages of copepod.

Distribution.—United States (Woods Hole, Mass., Tortugas, Fla., and Monterey Bay, Calif.) and (?) Canada.

Specimens.—U.S.N.M. Helm. Coll. Nos. 4874 (cotypes of *Nitzschia papillosa*) and 8537 (cotypes of *Udonella socialis*).

Udonella caligorum was first reported from this country by Linton (1898) as *Nitzschia papillosa*, the description being based upon specimens collected by the late Vinal N. Edwards at Woods Hole, Mass., December 15, 1885, from the (?) gills of *Gadus callarias*. The description was very incomplete and the illustrations inadequate. Owing to the incompleteness of the description and figures, Monticelli (1904) secured the cotype specimens and redescribed the species as *Lintonia papillosa*, placing his newly created genus *Lintonia* in the family Monocotylidae. Later, Linton (1910) described as a new species, *Udonella socialis*, a form which he found on "Argulus sp." from the mouth of *Neomaenis griseus* at Tortugas, Fla. More recently Guberlet (1936) described *Calinella myliobati* from specimens found on a copepod, *Trebius latifurcatus*, parasitic on *Myliobatis californicus* from Monterey Bay, California. A comparison of the type specimens of *N. papillosa* (= *L. papillosa*), *U. socialis* and *C. myliobati* has shown that these species are apparently identical with the European *Udonella caligorum* Johnston (1835) from *Caligus* sp. parasitic on the halibut, *Hippoglossus vulgaris*. *U. caligorum* has also been reported by Stafford (1904) from *Caligus* sp. on *Gadus callarias* from Canada; none of the latter species was available for study.

U. caligorum seems to be quite variable as regards size, the variation in length ranging from "about 4 lines," according to Johnston (5 to 6 mm according to Beneden (1858); 4 mm according to Stafford (1905)), to less

than 2 mm in specimens available to the writer. The specimen of *U. caligorum* from England reported by Baylis and Jones (1933) were made available for comparison through the courtesy of Doctor Baylis, and a study of these specimens showed no essential differences, either in size or in other respects, between them and the specimens from the United States.

Genera inquirenda

Genus ECHINELLA Beneden and Hesse, 1863

Diagnosis.—Body elongate, cylindrical, annulated. Posterior haptor relatively large, sucker-like. Pharynx with 2 chitinous hooks; intestine (?).

Type species.—*Echinella hirundinis* Beneden and Hesse, 1863.

Genus PTERONELLA Beneden and Hesse, 1863

Diagnosis.—Body elongate, annulated when young. Anterior end with ciliated aliform membrane. Posterior haptor relatively large, sucker-like. Pharynx armed with a large number of chitinous stylets; intestine (?).

Type species.—*Pteronella molvae* Beneden and Hesse, 1863.

No representatives of these very inadequately characterized genera have been reported from North America.

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